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APPLICATION NUMBER: 60/362,930

FILING DATE: March 11, 2002

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PROVISIONAL APPLICATION FOR PATENT COVER SHEET

This is a request for filing a **PROVISIONAL APPLICATION FOR PATENT** under 37 CFR 1.53(c).

Express Mail Label No.

INVENTOR(S)

INVENTOR(S)						
Given Name (first and middle [if any])	Family Name or Surname	Residence (City and either State or Foreign Country)				
Robert Michael	KLINE SHENFIELD	Richmond Hill, CANADA Richmond Hill, CANADA				
<input type="checkbox"/> Additional inventors are being named on the _____ separately numbered sheets attached hereto						
TITLE OF THE INVENTION (280 characters max)						
SYSTEM AND METHOD OF PRE-EMPTIVELY PUSHING DATA TO A MOBILE DEVICE						
Direct all correspondence to: CORRESPONDENCE ADDRESS <input type="checkbox"/> Customer Number <input type="text"/> → Place Customer Number Bar Code Label here						
OR Type Customer Number here						
<input checked="" type="checkbox"/> Firm or Individual Name	Krishna K. Pathiyal, Esq.					
Address	'Research In Motion Limited'					
Address	295 Phillip Street					
City	Waterloo	State	Ontario	ZIP	N2L 3W8	
Country	CANADA	Telephone	(519)888-7465		Fax (519)888-1975	
ENCLOSED APPLICATION PARTS (check all that apply)						
<input checked="" type="checkbox"/> Specification	Number of Pages	29	<input type="checkbox"/> CD(s), Number	<input type="text"/>		
<input checked="" type="checkbox"/> Drawing(s)	Number of Sheets	5	<input checked="" type="checkbox"/> Other (specify)	<input type="text"/> Power of Attorney		
<input type="checkbox"/> Application Data Sheet. See 37 CFR 1.76						
METHOD OF PAYMENT OF FILING FEES FOR THIS PROVISIONAL APPLICATION FOR PATENT						
<input type="checkbox"/>	Applicant claims small entity status. See 37 CFR 1.27.					FILING FEE AMOUNT (\$)
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The invention was made by an agency of the United States Government or under a contract with an agency of the United States Government.						
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<input type="checkbox"/> Yes, the name of the U.S. Government agency and the Government contract number are: _____						

Respectfully submitted,

Date | 03/08/02

SIGNATURE

REGISTRATION NO.

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Docket Number:

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APPLICATION

44435

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This collection of information is required by 37 CFR 1.51. The information is used by the public to file (and by the PTO to process) a provisional application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 8 hours to complete, including gathering, preparing, and submitting the complete provisional application to the PTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, Washington, D.C. 20231. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Box Provisional Application, Assistant Commissioner for Patents, Washington, D.C. 20231.

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FEE TRANSMITTAL for FY 2002

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TOTAL AMOUNT OF PAYMENT (\$ 160.00)

Complete if Known

Application Number	
Filing Date	
First Named Inventor	Robert KLINE
Examiner Name	
Group Art Unit	
Attorney Docket No.	PUS-0543

METHOD OF PAYMENT

1. The Commissioner is hereby authorized to charge indicated fees and credit any overpayments to:

Deposit Account Number **50-1995**Deposit Account Name **Research In Motion Limited** Charge Any Additional Fee Required Under 37 CFR 1.16 and 1.17 Applicant claims small entity status. See 37 CFR 1.272. Payment Enclosed: Check Credit card Money Order Other

FEE CALCULATION

1. BASIC FILING FEE

Large Entity Fee Code (\$)	Small Entity Fee Code (\$)	Fee Description	Fee Paid
101	740	201 370 Utility filing fee	
105	330	206 165 Design filing fee	
107	510	207 255 Plant filing fee	
108	740	208 370 Reissue filing fee	
114	160	214 80 Provisional filing fee	160.00

SUBTOTAL (1) (\$ 160.00)

2. EXTRA CLAIM FEES

Total Claims	Extra Claims	Fee from below	Fee Paid
Independent	-20*	=	
Claims	-3**	=	
Multiple Dependent		=	

Large Entity Fee Code (\$)	Small Entity Fee Code (\$)	Fee Description
103	18	203 9 Claims in excess of 20
102	84	202 42 Independent claims in excess of 3
104	280	204 140 Multiple dependent claim, if not paid
109	84	209 42 ** Reissue independent claims over original patent
110	18	210 9 ** Reissue claims in excess of 20 and over original patent

SUBTOTAL (2) (\$)

**or number previously paid, if greater; For Reissues, see above

FEE CALCULATION (continued)

3. ADDITIONAL FEES

Large Entity Fee Code (\$)	Small Entity Fee Code (\$)	Fee Description	Fee Paid
105	130	205 65 Surcharge - late filing fee or oath	
127	50	227 25 Surcharge - late provisional filing fee or cover sheet	
139	130	139 130 Non-English specification	
147	2,520	147 2,520 For filing a request for ex parte reexamination	
112	920*	112 920* Requesting publication of SIR prior to Examiner action	
113	1,840*	113 1,840* Requesting publication of SIR after Examiner action	
115	110	215 55 Extension for reply within first month	
116	400	218 200 Extension for reply within second month	
117	920	217 460 Extension for reply within third month	
118	1,440	218 720 Extension for reply within fourth month	
128	1,960	228 980 Extension for reply within fifth month	
119	320	219 160 Notice of Appeal	
120	320	220 160 Filing a brief in support of an appeal	
121	280	221 140 Request for oral hearing	
138	1,510	138 1,510 Petition to institute a public use proceeding	
140	110	240 55 Petition to revive - unavoidable	
141	1,280	241 640 Petition to revive - unintentional	
142	1,280	242 640 Utility issue fee (or reissue)	
143	460	243 230 Design issue fee	
144	620	244 310 Plant issue fee	
122	130	122 130 Petitions to the Commissioner	
123	50	123 50 Processing fee under 37 CFR 1.17(q)	
126	180	126 180 Submission of Information Disclosure Stmt	
581	40	581 40 Recording each patent assignment per property (times number of properties)	
146	740	246 370 Filing a submission after final rejection (37 CFR § 1.129(a))	
149	740	249 370 For each additional invention to be examined (37 CFR § 1.129(b))	
179	740	279 370 Request for Continued Examination (RCE)	
169	900	169 900 Request for expedited examination of a design application	
Other fee (specify) _____			

*Reduced by Basic Filing Fee Paid SUBTOTAL (3) (\$)

SUBMITTED BY

Name (Print/Type)	Krishna K. Pathiyal, Esq.	Registration No. (Attorney/Agent)	44435	Telephone	(519) 888-7465 x 2535	
Signature					Date	03/08/02

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VIA COURIER

March 8, 2002

BOX PROVISIONAL APPLICATION

Assistant Commissioner for Patents

Washington, D.C. 20231

USA

Dear Sir:

Re: **NEW PROVISIONAL PATENT APPLICATION**
Title: **SYSTEM AND METHOD OF PRE-EMPTIVELY PUSHING DATA TO A
MOBILE DEVICE**
Inventor(s): **Robert Kline; Michael Shenfield**
Our Ref: **PUS-0543**

Enclosed in connection with this new provisional patent application are the following:

	<u>Number of Pages</u>
(1) Provisional Application for Patent Cover Sheet (including fee payment and method)	1
(2) Fee Transmittal Sheet	2
(3) Specification	29
(4) Drawing(s)	No. of Figures: <u>5</u> 5
(5) Power of Attorney	2
(6) Receipt Card	1

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In sum, please charge the following fees to our deposit account as indicated on the Cover Sheet:

Filing fee of \$160.00

Yours very truly,

Krishna K. Pathiyal
Patent Agent

Encl.

SYSTEM AND METHOD OF PRE-EMPTIVELY PUSHING DATA TO A MOBILE DEVICE

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention is directed toward an advanced method of pre-emptively pushing information to be used automatically at a mobile data communications device ("mobile device"). The pushed information could be appended to traditionally pushed information as a result of an information pull request by the mobile device. One standard method for performing pull requests is to use a standard known as Wireless Application Protocol (WAP). The solution proposed here can be used with WAP, HTML (HyperText Markup Language), cHTML (compressed HTML), xHTML (Extensible HTML), XML (Extensible Markup Language) and many other information standards and protocols that have been used in the past, or may emerge. Some aspects of the present invention are also applicable to enabling select pre-emptively pushed information to be used automatically at a mobile device.

2. Description of the Related Art

Immobile data access techniques are well known and have enjoyed an immense success to the benefit of immobile users. These techniques are practised for instance on networked personal computers connected to a wide area network (WAN), such as the Internet. The WAN is typically a collection of wired local area networks (LANs) such as corporate networks or small office/home office (SOHO) networks, with the occasional singleton host computer, all of which are typically connected to the WAN via signals carried over a wire or fibre.

In sharp contrast, a typical mobile user may be disappointed with some aspects of current mobile data access techniques. Known mobile data access techniques may appear to suffer from

latency, narrower bandwidth, and less reliable data connections. These inconveniences reflect the fact that mobile data technology typically has a wireless component: a mobile device is typically connected to the WAN via signals carried wirelessly, such as using radio frequency (RF) waves or infrared (IR).

Traditional wireless technology may have limitations such as signal propagation delays, limited RF spectrum, and signal fade-outs, each of which may account at least in part for the higher latency, narrower bandwidth, and less reliable data connections respectively experienced by mobile data users.

Furthermore, the mobility of a mobile device may make mobile users less predictable than immobile users, as a mobile user may access data from virtually anywhere at virtually any time.

There is a need for mobile infrastructure that enhances the mobility paradigm, while mitigating some of the aforementioned inconveniences.

There is a further need for techniques that mask the mobile inconveniences from the mobile device user (also referred to hereinafter as a subscriber).

There is yet a further need for a subscriber activity analysis system and method that makes intelligent predictions of a mobile user's actions to pre-emptively push data to the mobile device.

3. Summary of the Invention

According to the present invention, there is provided a system for preemptively pushing data to a mobile device. The system includes a prediction server and a prediction client. The prediction server in turn includes a Data Collection Unit (DCU) a Data Adjustment Unit (DAU), an Analysis and Prediction Unit (APU), and a Data Preparation and Push Unit (DPPU). The prediction client, which is preferably embodied in the mobile device, is a counterpart of the prediction sever, the client consisting of a State Reporting Agent (SRA), and a Data Store (DS) 320 for pushed data, both of which are configured to operate with a plurality of data applications at the mobile device.

According to another aspect of the present invention, there is provided a method of preemptively pushing data to a mobile device includes the steps of receiving a pull request, and sending preemptively pushed data in response to the pull request along with the requested data. Optional steps include subscriber activity modeling, training phases, and operational phases.

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BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is an overview of an example communication system in which a mobile device may be used;

Fig. 2 is a diagram that shows interactions between the different parts of the system;

Fig. 3 shows a weighted graph modeling wireless subscriber activity;

Fig. 4 shows a transition matrix T structure and adjustment process during the training phase; and

Fig. 5 is a schematic diagram of components that could make up a wireless device that could be used as a mobile device with the invention.

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DETAILED DESCRIPTION OF THE DRAWINGS

Referring now to Fig. 1, Fig. 1 is an overview of an example communication system in which a mobile device may be used. One skilled in the art will appreciate that there may be hundreds of different topologies, but the simple system shown in Fig. 1 helps demonstrate the operation of the pre-emptive push systems and methods described in the present application.

Fig. 1 shows a data portal 10, the Internet 20, a data server 40, a wireless gateway 85, wireless infrastructure 90, a wireless network 105 and a mobile device 100. The data portal and server used in the example are for WAP, although any traditionally pull-based data portal or server, such as an HTML, cHTML, xHTML, XML servers and portals can be used instead of or at the same time as WAP. In practice, portal 10 and server 40 are functionally equivalent, i.e. a portal is a data server, except that a mobile carrier typically administers portal 10.

A WAP portal 10 may for example be connected to a carrier or an ISP (Internet Service Provider) on which a user of the system 10 has an account, located within a company, possibly connected to a local area network (LAN), and connected to the Internet 20, or connected to the Internet 20 through a large ASP (application service provider) such as America Online (AOL). Those skilled in the art will appreciate that the systems shown in Fig. 1 may instead be connected to a wide area network (WAN) other than the Internet, although WAP transfers are commonly accomplished through Internet-connected arrangements as shown in Fig. 1.

The WAP portal 10 may be implemented for example on a network computer within the firewall of a corporation or carrier, a computer within an ISP or ASP system or the like, and acts as one interface for information exchange over the Internet 20. Intermediate components are not shown in Fig. 1, as they do not directly play a role in the preemptive push described below. WAP

servers such as portal 10 typically extend beyond just WAP serving; they may also include dynamic database storage engines that have predefined database formats for data like calendars, to-do lists, task lists, e-mail and documentation. WAP portal 10 may also provide links to information that it serves, such as deck 17, as well as to information served by other servers, such as deck 17' served by WAP server 40.

The wireless gateway 85 and infrastructure 90 provide a link between the Internet 20 and wireless network 105, collectively forming an exemplary information transfer mechanism. The wireless infrastructure determines the most likely network for locating a given user and tracks the user as they roam between countries or networks. A WAP deck 17, for instance as requested by a mobile device user, is delivered to the mobile device via wireless transmission, typically at a radio frequency (RF), from a base station in the wireless network 105 to the mobile device 100. The particular network 105 may be virtually any wireless network over which information may be exchanged with a mobile device.

As shown in Fig. 1, mobile device 100 sends a Uniform Resource Identifier (URI) URI0 15 corresponding to a resource request from portal 10. This URI 15 is exemplary, as substantially the same behavior occurs if mobile device 100 sends a URI request to any server 40 located somewhere on the Internet 20. Thus URI0 15 is, for instance a WAP request for WAP deck0 17. The URI0 request 15 arrives to the portal 10 and is normally responded to by portal 10 sending WAP deck 17 to the mobile device 100. These techniques are all well known to those skilled in the art. Most known systems support this so-called "pull" access scheme, wherein a mobile device must request that the portal send the deck to the device.

Regardless of the specific information transfer mechanism controlling the sending of decks to a mobile device 100, the deck 17, is sent via the wireless gateway 85. The wireless infrastructure 90 includes a series of connections to wireless network 105. These connections could be Integrated Services Digital Network (ISDN), Frame Relay or T1 connections using the TCP/IP protocol used throughout the Internet. As used herein, the term "wireless network" is intended to include three different types of networks, those being (1) data-centric wireless networks, (2) voice-centric wireless networks and (3) dual-mode networks that can support both voice and data communications over the same physical base stations. The newest of these combined dual-mode networks include, but are not limited to (1) the Code Division Multiple Access (CDMA) network that has been developed and is operated by Qualcomm, (2) the Groupe Special Mobile or the Global System for Mobile Communications (GSM) and the General Packet Radio Service (GPRS) network both developed by the standards committee of CEPT, and (3) the future third-generation (3G) networks like Enhanced Data-rates for Global Evolution (EDGE) and Universal Mobile Telecommunications Systems (UMTS). GPRS is a data overlay on the very popular GSM wireless network, operating in virtually every country in Europe. Some older examples of data-centric network include the Mobitex™ Radio Network, which has been developed by Eritel and Ericsson of Sweden, and is operated by BellSouth (Cingular) Wireless Data in the United States and Rogers/Cantel in Canada, and the DataTAC™ Radio Network, which has been developed by Motorola and is operated by American Mobile Satellite Corporation (AMSC), now called Motient, in the United States and Bell Mobility in Canada. Examples of older voice-centric data networks include Personal Communication Systems (PCS) networks like CDMA, GSM, and TDMA systems that have been available in North America and world-wide for nearly 10 years.

The simple system shown in Fig. 1 illustrates two cases. First, the case where the URI0 15 requested deck0 17 is transferred to the mobile device is illustrated. This case is known in the art, and will not be discussed any further.

Finally, the case where not only deck 17 is transferred to the mobile device, but also pre-emptive information 18 is “pushed” along with deck0 17 in accordance with the present invention, is illustrated. Pre-emptive information 18 in the WAP example illustrated includes at least one pre-emptive URI1 15’ and deck1 17’, whose request was predictably anticipated in accordance to the present invention. For instance, URI1 15’ could be related to a link found in deck0 17 of server 10. As illustrated, URI 15’, if requested by the mobile device 100, would traditionally result in deck1 17’ being sent to mobile device 100. If the user of mobile device 100, after receiving pre-emptive information 18 requests URI1 15’, mobile device 100 need not actually make the request as deck1 17’ is already available at the mobile device 100. According to this aspect of the invention, a traditional request is pre-empted according to the present invention, thereby reducing user perceived latency at the mobile device 100. This case will be described in greater detail with reference to Figs. 2 to 4 below.

Fig. 2 is a diagram that shows interactions between the different parts of the system in an exemplary prediction client/server embodiment. The server side of the system will be described first, after which the client side of the system will be described.

The server side of the system consists of a prediction server 200, which as illustrated in the example of Fig. 2 is embodied in the wireless gateway 85 of Fig. 1. The example prediction server includes the following components:

- Data Collection Unit (DCU) 210
- Data Adjustment Unit (DAU) 220

- Analysis and Prediction Unit (APU) 230
- Data Preparation and Push Unit (DPPU) 240

The client side of the system consists of a prediction client 300, which as illustrated in the example of Fig. 2 is embodied in the mobile device 100, and is a counterpart of sever 200, the example client 300 consisting of:

- State Reporting Agent (SRA) 310
- Data Store (DS) 320 for pushed data (browser cache or mobile application-specific)

Also illustrated is data application 330, which may optionally be, but preferably is not a part of, the prediction client 300. Application 330 cooperates with prediction client 300, for instance, by checking DS 320 for cached information before issuing a data pull request. In the example of WAP, data application 330 is a WAP browser.

The Data Collection Unit (DCU) 210 consists of two main parts: the device state listener and the state storage component (not shown in the drawing). When the mobile device is reporting a new state, the state listener receives the data (device ID and state URI (Universal Resource Identifier)) and redirects it to the state storage component. In alternate embodiments, the device state listener could be implemented as one of the following: socket server, stream connection listener, or servlet. The device state listener could be embodied using software as a stand-alone process or as a thread within the DCU 210 or prediction server 200. The state storage component consists of the raw data storage of states received from the device state listener (waiting for processing) and hierarchical data storage of states structured according to the user(s) historical activity patterns. Raw data storage is short lived and transient, hierarchical data storage

is persistent and could be implemented using a relational or object database, XML data store, or serialized files.

The Data Adjustment Unit (DAU) 220 is notified when a new state reaches the raw data storage of the DCU 210. The DAU 220 removes the state URI and device ID from the raw data storage and then pools the corresponding historical data from the DCU's hierarchical data storage. It transforms the data according to a prediction algorithm, such as for example Markov weighted probabilities, two-way sorting, etc., and stores the data back to the DCU 210. In a preferred embodiment of the DAU 220, software carries out the steps of the method and uses two separate threads – one for new state notification, and another for state processing.

The Analysis and Prediction Unit (APU) 230 is notified when the DAU 220 completes processing of a new state. It pools corresponding data from the DCU 210, and using the prediction algorithm makes an intelligent prediction of the most likely user navigation steps following the current device 100 state. The inventors envisage the use of at least 3 distinct prediction modes: atomic, group, and mixed. Atomic mode operates with the historical information of a single user (device) or relatively small group of homogeneous users, and makes predictions based on this information only. Group mode operates with a much greater data sample collected on a large user population. Mixed mode operates with the user specific data first and, if there is not enough information to make a strong prediction (e.g. either the preference pattern is not recognizable or the sub-graph has not yet been visited by the user), it switches to the group mode data to make a prediction. Each prediction mode has its benefits and drawbacks and, therefore, mode selection should depend on the uniformity level of the user population and application specifics, as would be apparent to a person skilled in the art.

The Data Preparation and Push Unit (DPPU) 240 receives a collection of forecasted state URIs from the APU 230. A method at the DPPU 240 executes the following steps:

- Pulls URI data from the Internet or corporate intranet. This step can be optimized with content caching (subject to the expiration parameters in the content header).
- Prepares push data: packs URIs into a single buffer (device and gateway specific) for transmission to the device. The DPPU method can also perform some additional optimization steps (e.g. content trans-coding or compression) if required.
- Redirects prepared data to a mobile gateway (server) to execute the push to the device.

Some of the tasks in the second step are subject to the availability of mobile gateway 85 (server) capabilities and could be executed by the gateway rather than the prediction server in alternate embodiments.

The device side State Reporting Agent (SRA) 310 interacts with a particular device application 330 (e.g. mobile browser) and gets notified when a user requests a specific URI. When notified, the SRA 310 uses the wireless connection (connection type depends on the device and wireless infrastructure specifics as described above in reference to Fig. 1) to transmit URI data to the server side DCU 210.

Device Data Store (DS) 320 interacts with a push connection agent (or with any available push notification mechanism) to receive the set of URI data transmitted by the server. In alternate embodiments, the DS 320 could work either as stand-alone data storage for a single application/multiple applications, or as a mediator that passes data along to the prediction event listeners of the applications registered with the DS 320. In the case of correct prediction

(prediction hit), the user's next selection will be satisfied from the local device storage with virtually zero latency.

A method will now be described in reference to Fig. 2, the method including the steps of:

Step 1 - new state notification, whereby SRA 310 sends state information to DCU 210;

Step 2 - new state recorded, whereby DCU 210 notifies DAU 220;

Step 3 - transition matrix adjusted, whereby DAU 220 adjusts the transition matrix and notifies DCU 210;

Step 4 - new state notification, whereby DAU 220 notifies APU 230;

Step 5 - pattern analysis, whereby DCU 210 and APU 230 co-operate to recognize subscriber activity patterns or trends;

Step 6 - data request for preemptive push, whereby APU 230 requests data to be pushed by DPPU 240;

Step 7 - data query from Internet / corporate Intranet, whereby DPPU 240 receives data to be pushed; and

Step 8 - data set compilation and push to mobile device, whereby DPPU 240 pushes data to mobile device.

Also shown is optional step 9 whereby device application 330 issues a traditional data pull request (DPR), which can be used as a trigger for initiating any one or several of the steps 1 through 8 described above.

Referring now to Fig. 3, Fig. 3 shows a weighted graph modeling wireless subscriber activity provided in accordance with the present invention. A mobile subscriber activity model can be described by a weighted directional graph, as illustrated in Fig. 3, where each edge

represents two directions. As illustrated, if an edge exists between any two arbitrary vertices A and B, then the edge represents both transition from vertex A to B and from B back to A, and has a pair of associated weights (W_{AB} , W_{BA}), one weight per direction. For example, the edge connecting vertices V1 and V2 has weights (W_{12} , W_{21}). The vertices V_k in the graph correspond to the information states of a wireless device and represent atomic information units like cHTML or xHTML pages, WAP decks, data screens, etc... In this regard, the edges denote bi-directional transitions between the information states. There is a pair of numeric weights associated with each edge. In alternate embodiments, the weight could represent the number (or frequency) of transitions along each direction of the edge during the observation (or training) period. It could also represent any other decision supporting measure based on subscriber historic activity.

The goal of the present method is to predict most likely subset of future transitions (edges) and information units (vertices) based on the current information state of the mobile device (zero vertex) and historically accumulated user activity data represented by edge weights. When the most likely set of future information units is identified, it is pushed to the mobile device to minimize data access latency observed by a subscriber by preferably pre-empting pull requests before they occur.

There are a vast variety of mathematical models that could be used to implement a self-learning system. Given a strong directional pattern of the graph and probability driven decision process for transitions from each vertex, as would be apparent to a person skilled in the art. In the present description, a Markov chain model will be described.

The weighted directional graph of Fig. 3 can be adapted as a Markov chain by ensuring that edge weights are probabilities of transitions between states (vertices). To accomplish this step, the activity graph should be normalized in order for each vertex to have the total weight of

outgoing edges to be equal to 1. The resulting model will operate with the Markov chain states corresponding to atomic units of information (e.g. cHTML or xHTML documents, WAP decks, data screens, etc.) and transitions that represent mobile user navigation from one information unit to another, i.e. URI requests which are to be predictably pre-empted.

Ordinarily, a Markov chain model with n states $S=\{s_1, s_2, \dots, s_n\}$ is fully described by a state vector Z_t and transition matrix T . At any discrete moment t the state of the system can be stochastically defined using the formula:

$$Z_t = T Z_{t-1} = T^{t-1} Z_0,$$

where Z_0 is an initial state of the chain.

Consider a further specification of a Markov chain model that is a history-determined Markov chain. Unlike regular or state-determined chain, the future state of history-determined Markov chain is described by not only the current state of the chain but rather by a finite sequence of preceding states. This class of Markov chains is better suited to model dynamic systems and the preferred candidate model for the self-learning system aspect provided according to the present invention. For a generic history-determined chain the state vector can be defined as:

$$Z_t = F(Z_{t-1}, Z_{t-2}, \dots, Z_{t-k}),$$

where F is a state transformation function and k is a history “depth”.

The set $(Z_{t-1}, Z_{t-2}, \dots, Z_{t-k})$ is a historic states pattern. Learning algorithms using historic states patterns are preferable over single states as prediction results will better.

Next, consider the following specification of a wireless environment model:

- Cardinality of a Markov chain model for a generic multi-user environment is virtually indefinite: $\lim_{t \rightarrow \infty} |S_t| = \infty$, and tends to cover the whole sample space Ω ;
- Cardinality of a Markov chain modeling an activity of a single user or a homogeneous group of users is much smaller and a vector of states $S_t = \{s_1, s_2, \dots, s_n\}$ at any given time t represents only a tiny subset of Ω .
- For a single user model (or a homogeneous group of users) the following assumption is correct (stochastic limitation of a state set cardinality):
 - if θ_t is an *observed* state of the model at a moment t then:
 - $\forall \rho > 0 \exists n < \infty : P\{\theta_t \in S_t\} > 1 - \rho$ and $|S_t| < n$,
where $P\{A\}$ is the probability of event A.

СИБУР

Training phase:

Referring now to Fig. 4, Fig. 4 shows a transition matrix T structure and adjustment process during the training phase.

The following method could be used for the dynamic adjustment of the states vector S and transition matrix T 430 :

- Introduce collection frames 410. A collection frame is a time interval over which the model operates without changing S or T . At the end of each frame 410 the collected data is analyzed and S and T are adjusted for the next frame. During the training phase 420, model space S is likely to grow, in operational phase $|S|$ will likely stay steady even though the individual states might be added or removed reflecting user activity pattern changes. Frame size is expected to change in transition from training to operational phase: it is likely to grow till the system achieves stability.
- To adjust S at the end of the collection frame use frequency based approach: if state θ was visited by the system at least K times during the past frame the state is added to vector S . If state θ was not visited by the system during the past M frames the state is removed from S . Removal of unused (rarely used) model states is needed to ensure performance efficiency of the method. Optimal values of K and M depend on application specifics and size of controlled user group.

P_{ls}^r - is a transition probability from state l to s as per matrix 430 state at the end of frame r .

The following method step details the transition matrix adjustment process.

- At the end of collection frame 410 frequency matrix F represents state transitions during this frame:

$$\begin{vmatrix} 0 & f_{12} & \dots & f_{1n} \\ f_{21} & 0 & \dots & f_{2n} \\ \dots & f_{n2} & \dots & 0 \end{vmatrix} \quad F =$$

where:

- f_{ij} is a frequency of transitions from state i to state j
- n is a number of model states monitored during past collection frame: includes existing model states and new states visited more than K (threshold value) times during past collection frame.

Introduce weight coefficient α that represents a "refresh rate" for the transition matrix F .

Then the matrix T could be frame-adjusted using the following formula:

$$p_{ij} = \alpha f_{ij} + (1-\alpha) p_{ij}, \quad \text{if } i \text{ existed prior to the past frame}$$

$$p_{ij} = f_{ij}, \quad \text{otherwise}$$

Note: The formula above is identical to $T = \alpha F + (1-\alpha) T$ if transition matrix T is zero-extended for the new states prior to calculation.

The weight coefficient α should be adjusted during training and operational phases, $\alpha \rightarrow 0$ as the model matures.

To complete adjustment process we will remove unused (rarely used) states:

- remove rows for unused states – no further adjustment required.
- remove columns for unused states – requires probability normalization:

$$P_{ij} = P_{ij} / \sum_{j < m} P_{ij}, \text{ where } m \text{ is a new number of states.}$$

Transition to operational phase

Next consider steps for calculating t_s - the saturation point when the system migrates from the training to operational phase:

$$\Omega(\Delta T)_n < X,$$

where

Ω is a metric defined on the matrix ΔP

$(\Delta T)_n$ is a matrix of probability adjustments over the last collection frame n

X is a saturation point criterion.

For the purpose of this description, let X be a predefined scalar number that represents a quantitative upper boundary for the frame-to-frame transition matrix T adjustment and Ω be a norm defined on the matrix ΔT .

The following two matrix norms are suggested for this purpose:

- The Hilbert-Schmidt norm (sum of square differences):

$$|\Delta T|_2 = \sqrt{\sum_{i,j} (\Delta t_{ij})^2} < X \quad (1)$$

- The L1 maximum absolute column sum norm:

$$|\Delta T|_1 = \max_j \sum_{i=1..n} |\Delta t_{ij}| < X \quad (1)$$

Either of these norms provide a condition (1) for the selected matrix to satisfy over a number of consecutive frames, thereby triggering the system to change into an operational state.

Prediction

Prediction steps allow the system to forecast subscriber actions based on the current mobile device state and historically collected data about states space (S) and transitional probabilities between states (T).

General approach:

To describe the general steps for prediction process first define the variables:

- Prediction depth W is a maximum number of information units (Markov chain states) that is time / price efficient to direct to the mobile device during one push.
- Transition path Z_n is a set of ordered states $Z_n = \{z_1, z_2, z_3, \dots, z_n\}$ $n < W$

Examples:

i. (consequent) $x \rightarrow z_1 \rightarrow z_2 \rightarrow z_3 \rightarrow \dots \rightarrow z_n$

ii. (parallel) $x \rightarrow z_1 \rightarrow z_2$

$x \rightarrow z_3 \rightarrow \dots \rightarrow z_k$

$x \rightarrow z_2 \rightarrow z_5 \rightarrow \dots \rightarrow z_n$

where x is a current state of a mobile device.

The goal of the prediction steps is to predict an optimal (based on the historic data) path Z_n and push to the mobile device states z_1, \dots, z_n

- Probability metric P_{Zn} is a composite probability measure defined on the set Z_n to identify an optimal path out of all possible paths.
- Cost function C_k represents a cost of push data transmission for k pages
- Weight function $F_{Zn} = P_{Zn} + \beta C_n$, where β is a cost weight coefficient.

For every new state of the mobile device an algorithm solves optimization problem maximizing F_{Zn} over all possible Z_n sets: $n < W$

The pre-emptive push occurs when the $F_{Zn} > R_\theta$, where R_θ is a push validity threshold.

Next consider an extreme example of this general algorithm:

$$C_k = 0, W = 1$$

$$F_{Zn} = P_{Zn} = P_{Z_1}$$

$$P_{Z_1} = Pxi \quad (i \in S, x \text{ is a current device state})$$

The resulting $Z_1 = \{i\}$: $Pxi = \max_{j \in S} (Pxj), i \in S$

Pushing just a single data unit to the mobile device might prove practical for some information formats (e.g. WAP decks), but in most cases it is much more valuable to produce an extended forecast. Let's broaden the first example to the case when $W > 1$:

$$C_k = 0, W > 1$$

$$F_{Zn} = P_{Zn}$$

Let's introduce variable r_0 as a path selection threshold: state transition $i \rightarrow j$ is selected if

$$Pij > r_0.$$

Next define a selection process for a "candidate" set Z^c :

1. Select all states $z_1 : P_{xz_1} > r_0$ and add them to the set Z^c
2. For the states z_1 from step 1 select all states $z_2 : P_{z_1 z_2} > r_0$ and add them to the set Z^c while keeping path references (i.e. $x \rightarrow z_1 \rightarrow z_2$)
3. Continue the selection process till either $|Z^c| = W$ (simple case - no optimization required) or path length exceeds W : ($x \rightarrow z_1 \rightarrow z_2 \dots \rightarrow z_W$) or selection process cannot find any transition with $P_{z_k j} > r_0$ at the step $k < W$.

If $|Z^c| \leq W$, then $Z_n = Z^c$ - no optimization required.

If $|Z^c| > W$, then

$$Z_n \in Z^c : P_{zn} = \max_{n \leq W} P(Z^c)$$

Probability measure P can be defined as a simple sum of transition probabilities along the paths in Z^c . For more generic P it should be ensured that while finding a maximization subset of candidate set Z^c , the transition paths are kept intact, i.e. if the state z_m is chosen then all the states in a path from x to z_m are to be chosen as well.

Note: An alternate approach in Z^c selection is to increase threshold r_0 as the selection process moves away from the origin (current device state). This approach could accommodate

both cost considerations C_k and validity threshold R_0 and greatly simplify the prediction process.

Wireless Device:

Fig. 5 is a schematic diagram of components that could make up a wireless device that could be used as a mobile device with the invention.

Turning now to Fig. 5 there is a block diagram of a wireless device 900 in which portions of the instant invention may be implemented. The wireless device 900 is preferably a two-way communication device having at least voice and data communication capabilities. The device preferably has the capability to communicate with other computer systems on the Internet. Depending on the functionality provided by the device, the device may be referred to as a data messaging device, a two-way pager, a cellular telephone with data messaging capabilities, a wireless Internet appliance or a data communication device (with or without telephony capabilities).

Where the device 900 is enabled for two-way communications, the device will incorporate a communication subsystem 911, including a receiver 912, a transmitter 914, and associated components such as one or more, preferably embedded or internal, antenna elements 916 and 918, local oscillators (LOs) 913, and a processing module such as a digital signal processor (DSP) 920. As will be apparent to those skilled in the field of communications, the particular design of the communication subsystem 911 will be dependent upon the communication network in which the device is intended to operate. For example, a device 900 destined for a North American market may include a communication subsystem 911 designed to operate within the Mobitex mobile communication system or DataTAC mobile communication

system, whereas a device 900 intended for use in Europe may incorporate a General Packet Radio Service (GPRS) communication subsystem 911.

Network access requirements will also vary depending upon the type of network 919, such as Wireless Network 105 of Fig. 1. For example, in the Mobitex and DataTAC networks, mobile devices such as 900 are registered on the network using a unique personal identification number or PIN associated with each device. In GPRS networks however, network access is associated with a subscriber or user of a device 900. A GPRS device therefore requires a subscriber identity module (not shown), commonly referred to as a SIM card, in order to operate on a GPRS network. Without a SIM card, a GPRS device will not be fully functional. Local or non-network communication functions (if any) may be operable, but the device 900 will be unable to carry out any functions involving communications over network 919. When required network registration or activation procedures have been completed, a device 900 may send and receive communication signals over the network 919. Signals received by the antenna 916 through a communication network 919 are input to the receiver 912, which may perform such common receiver functions as signal amplification, frequency down conversion, filtering, channel selection and the like, and in the example system shown in Fig. 9, analog to digital conversion. Analog to digital conversion of a received signal allows more complex communication functions such as demodulation and decoding to be performed in the DSP 920. In a similar manner, signals to be transmitted are processed, including modulation and encoding for example, by the DSP 920 and input to the transmitter 914 for digital to analog conversion, frequency up conversion, filtering, amplification and transmission over the communication network 919 via the antenna 918.

The DSP 920 not only processes communication signals, but also provides for receiver and transmitter control. For example, the gains applied to communication signals in the receiver 912 and transmitter 914 may be adaptively controlled through automatic gain control algorithms implemented in the DSP 920.

The device 900 preferably includes a microprocessor 938, which controls the overall operation of the device. Communication functions, including at least data and voice communications, are performed through the communication subsystem 911. The microprocessor 938 also interacts with further device subsystems such as the display 922, flash memory 924, random access memory (RAM) 926, auxiliary input/output (I/O) subsystems 928, serial port 930, keyboard 932, speaker 934, microphone 936, a short-range communications subsystem 940 and any other device subsystems generally designated as 942.

Some of the subsystems shown in Fig. 5 perform communication-related functions, whereas other subsystems may provide "resident" or on-device functions. Notably, some subsystems, such as keyboard 932 and display 922 for example, may be used for both communication-related functions, such as entering a text message for transmission over a communication network, and device-resident functions such as a calculator or task list.

Operating system software used by the microprocessor 938 is preferably stored in a persistent store such as flash memory 924, which may instead be a read only memory (ROM) or similar storage element (not shown). Those skilled in the art will appreciate that the operating system, specific device applications, or parts thereof, may be temporarily loaded into a volatile store such as RAM 926. It is contemplated that received communication signals may also be stored to RAM 926. flash memory 924 preferably includes data communication module 924B, and when device 900 is enabled for voice communication, voice communication module 924A.

For the purposes of this invention, are also included in flash memory 924 other software modules 924N, which are also shown as prediction client 300 of Fig. 2.

The microprocessor 938, in addition to its operating system functions, preferably enables execution of software applications on the device. A predetermined set of applications which control basic device operations, including at least data and voice communication applications for example, will normally be installed on the device 900 during manufacture. A preferred application that may be loaded onto the device may be a personal information manager (PIM) application having the ability to organize and manage data items relating to the device user such as, but not limited to e-mail, calendar events, voice mails, appointments, and task items. Naturally, one or more memory stores would be available on the device to facilitate storage of PIM data items on the device. Such PIM application would preferably have the ability to send and receive data items, via the wireless network. In a preferred embodiment, the PIM data items are seamlessly integrated, synchronized and updated, via the wireless network, with the device user's corresponding data items stored or associated with a host computer system. Also preferred is a browser application, such as device application 330 of Fig. 2. Further applications may also be loaded onto the device 900 through the network 919, an auxiliary I/O subsystem 928, serial port 930, short-range communications subsystem 940 or any other suitable subsystem 942, and installed by a user in the RAM 926 or preferably a non-volatile store (not shown) for execution by the microprocessor 938. Such flexibility in application installation increases the functionality of the device and may provide enhanced on-device functions, communication-related functions, or both. For example, secure communication applications may enable electronic commerce functions and other such financial transactions to be performed using the device 900.

In a data communication mode, a received signal such as a text message or web page download will be processed by the communication subsystem 911 and input to the microprocessor 938, which will preferably further process the received signal for output to the display 922, or alternatively to an auxiliary I/O device 928. A user of device 900 may also compose data items such as e-mail messages for example, using the keyboard 932, which is preferably a complete alphanumeric keyboard or telephone-type keypad, in conjunction with the display 922 and possibly an auxiliary I/O device 928. Such composed items may then be transmitted over a communication network through the communication subsystem 911.

For voice communications, overall operation of the device 900 is substantially similar, except that received signals would preferably be output to a speaker 934 and signals for transmission would be generated by a microphone 936. Alternative voice or audio I/O subsystems such as a voice message recording subsystem may also be implemented on the device 900. Although voice or audio signal output is preferably accomplished primarily through the speaker 934, the display 922 may also be used to provide an indication of the identity of a calling party, the duration of a voice call, or other voice call related information for example.

The serial port 930, would normally be implemented in a personal digital assistant (PDA)-type communication device for which synchronization with a user's desktop computer (not shown) may be desirable, but is an optional device component. Such a port 930 would enable a user to set preferences through an external device or software application and would extend the capabilities of the device by providing for information or software downloads to the device 900 other than through a wireless communication network. The alternate download path may for example be used to load an encryption key onto the device through a direct and thus reliable and trusted connection to thereby enable secure device communication.

A short-range communications subsystem 940 is a further optional component which may provide for communication between the device 900 and different systems or devices, which need not necessarily be similar devices. For example, the subsystem 940 may include an infrared device and associated circuits and components or a Bluetooth™ communication module to provide for communication with similarly-enabled systems and devices.

Having described in detail the preferred embodiments of the present invention, including the preferred methods of operation, it is to be understood that this operation could be carried out with different elements and steps. This preferred embodiment is presented only by way of example and is not meant to limit the scope of the present invention.

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ABSTRACT

A system for pre-emptively pushing data to a mobile device includes a prediction server and a prediction client. The prediction server in turn includes a Data Collection Unit (DCU) a Data Adjustment Unit (DAU), an Analysis and Prediction Unit (APU), and a Data Preparation and Push Unit (DPPU). The prediction client, which is preferably embodied in the mobile device, is a counterpart of the prediction sever, the client consisting of a State Reporting Agent (SRA), and a Data Store (DS) 320 for pushed data, both of which are configured to operate with a plurality of data applications at the mobile device. A method of pre-emptively pushing data to a mobile device includes the steps of receiving a pull request, and sending pre-emptively pushed data in response to the pull request along with the requested data. Optional steps include subscriber activity modeling, training phase steps, and operational phase steps.

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First Named Inventor	Robert KLINE
Title	System And Method of...
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Attorney Docket Number	PUS-0543

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Country	CANADA		
Telephone	(519) 888-7465	Fax	(519) 888-1975

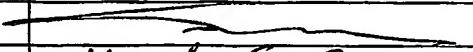
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First Named Inventor	Robert KLINE
Title	System And Method of...
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Krishna K. Pathiyal, Esq.

Address	Research In Motion Limited			
Address	295 Phillip Street			
City	Waterloo	State	Ontario	Zip N2L 3W8
Country	CANADA			
Telephone	(519) 888-7465	Fax	(519) 888-1975	

I am the:

Applicant/Inventor.

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Date	March 6 / 2002

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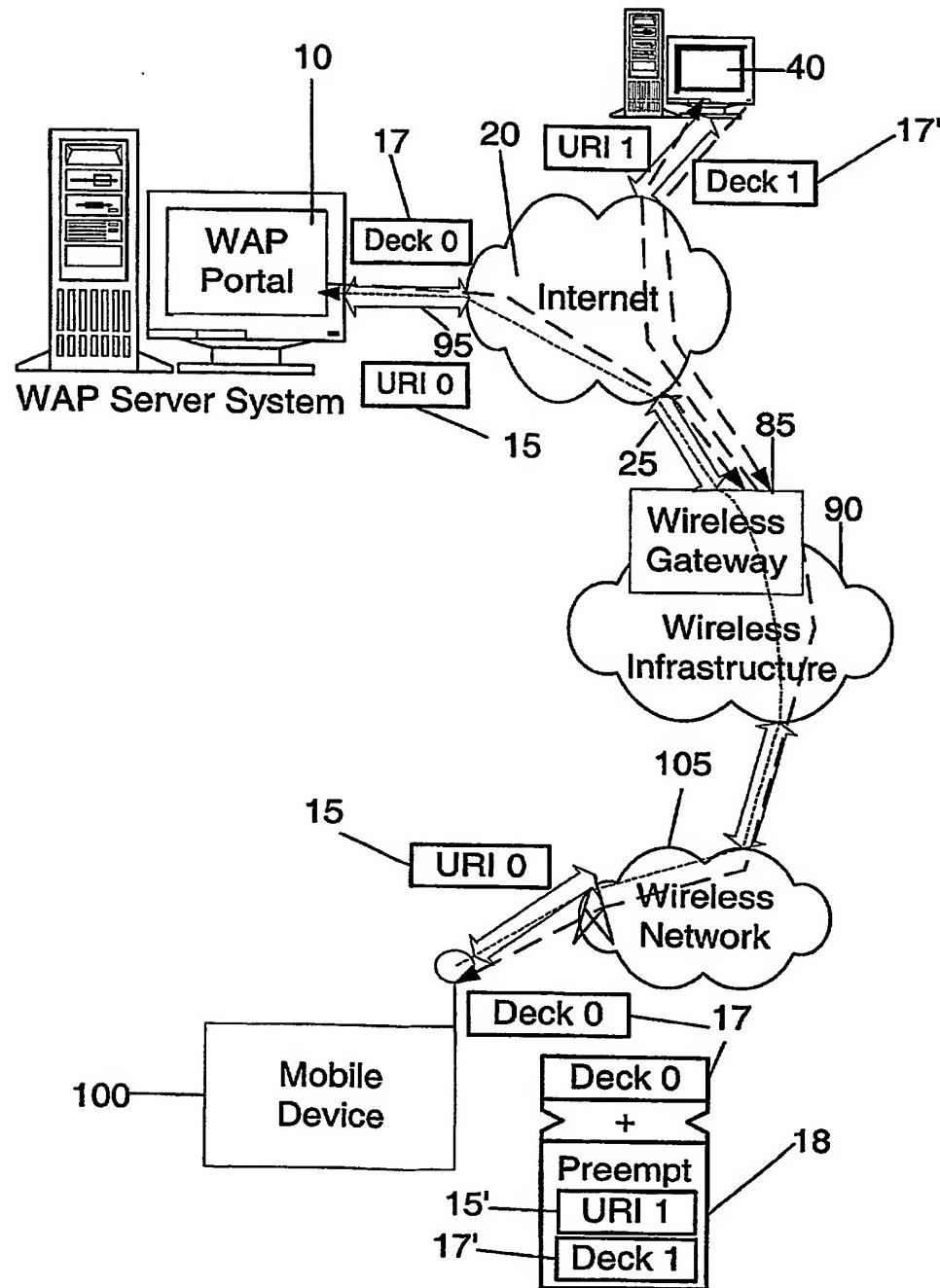


Fig. 1

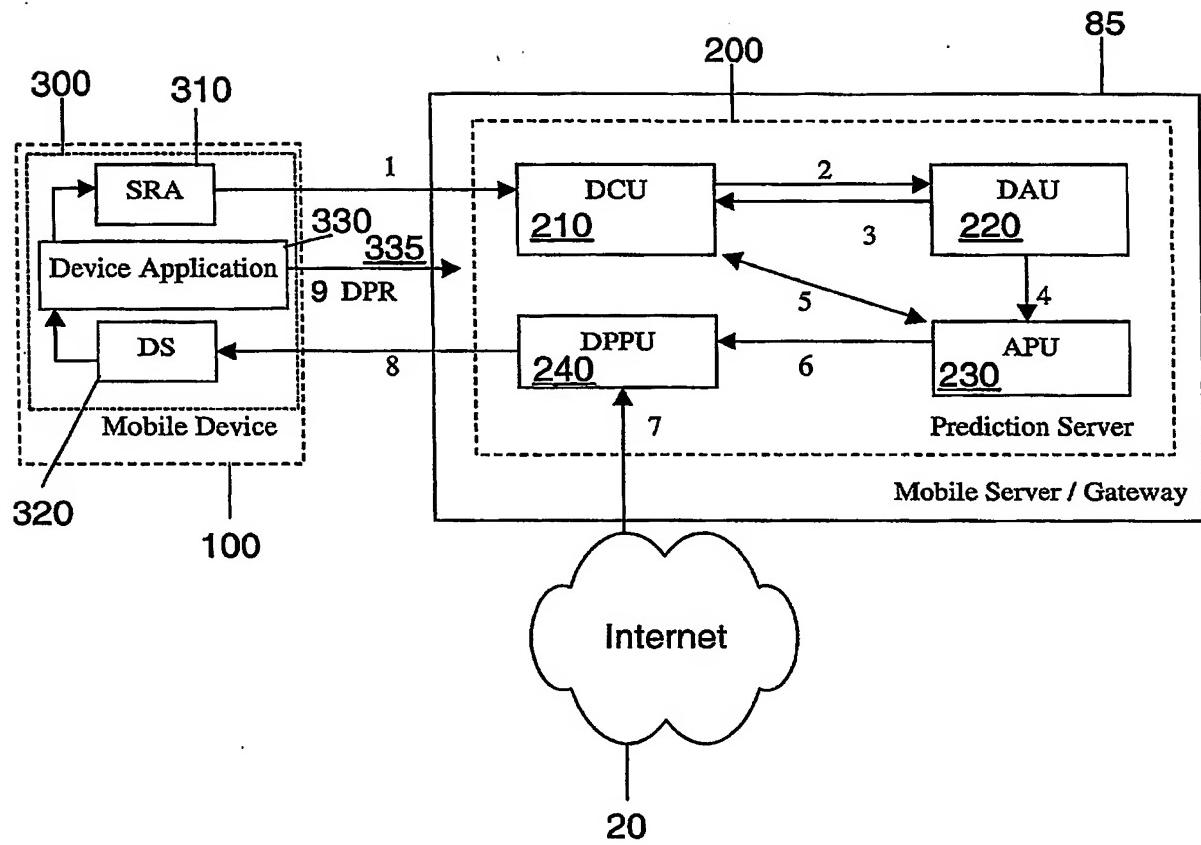


Fig. 2

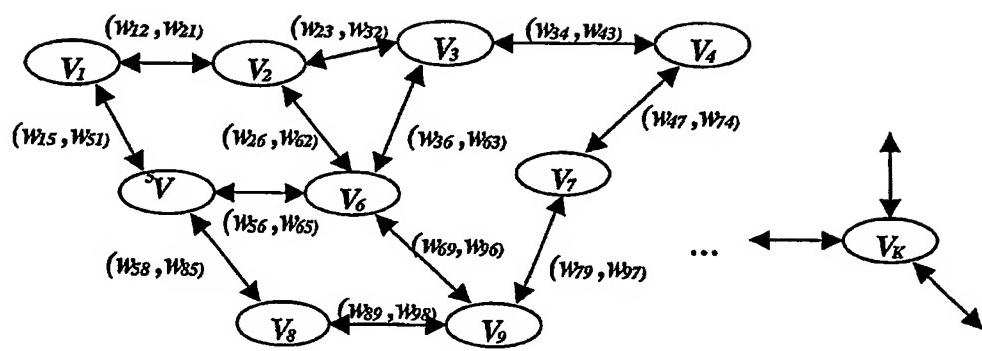


Fig.3

EEG ECG EKG PPG RPP

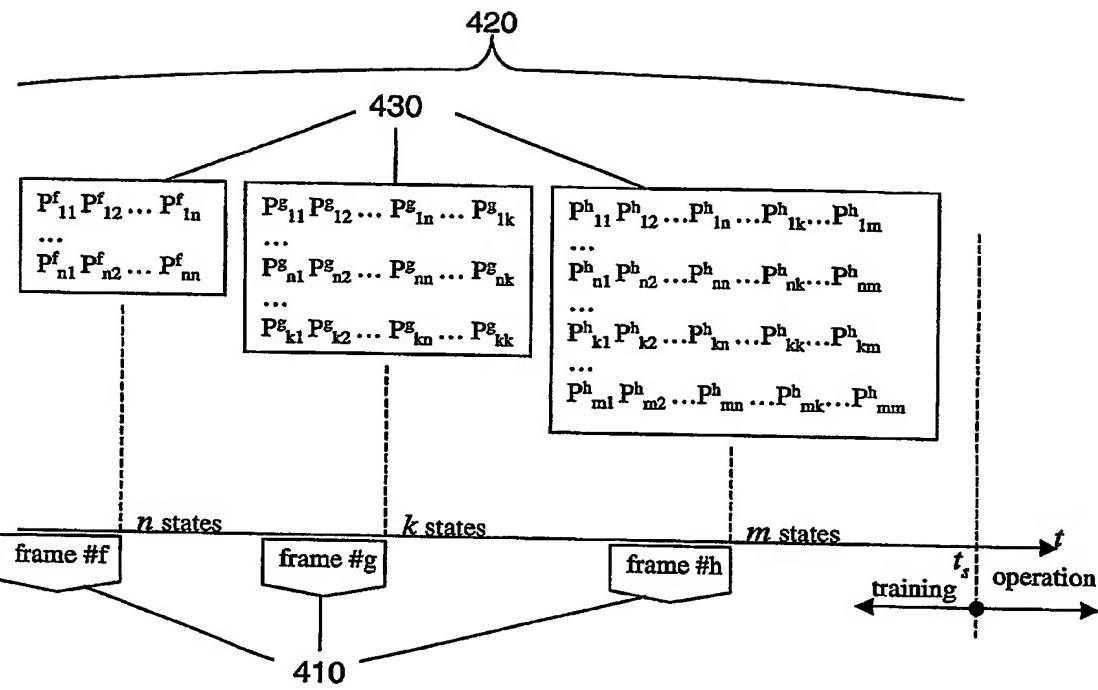


Fig. 4

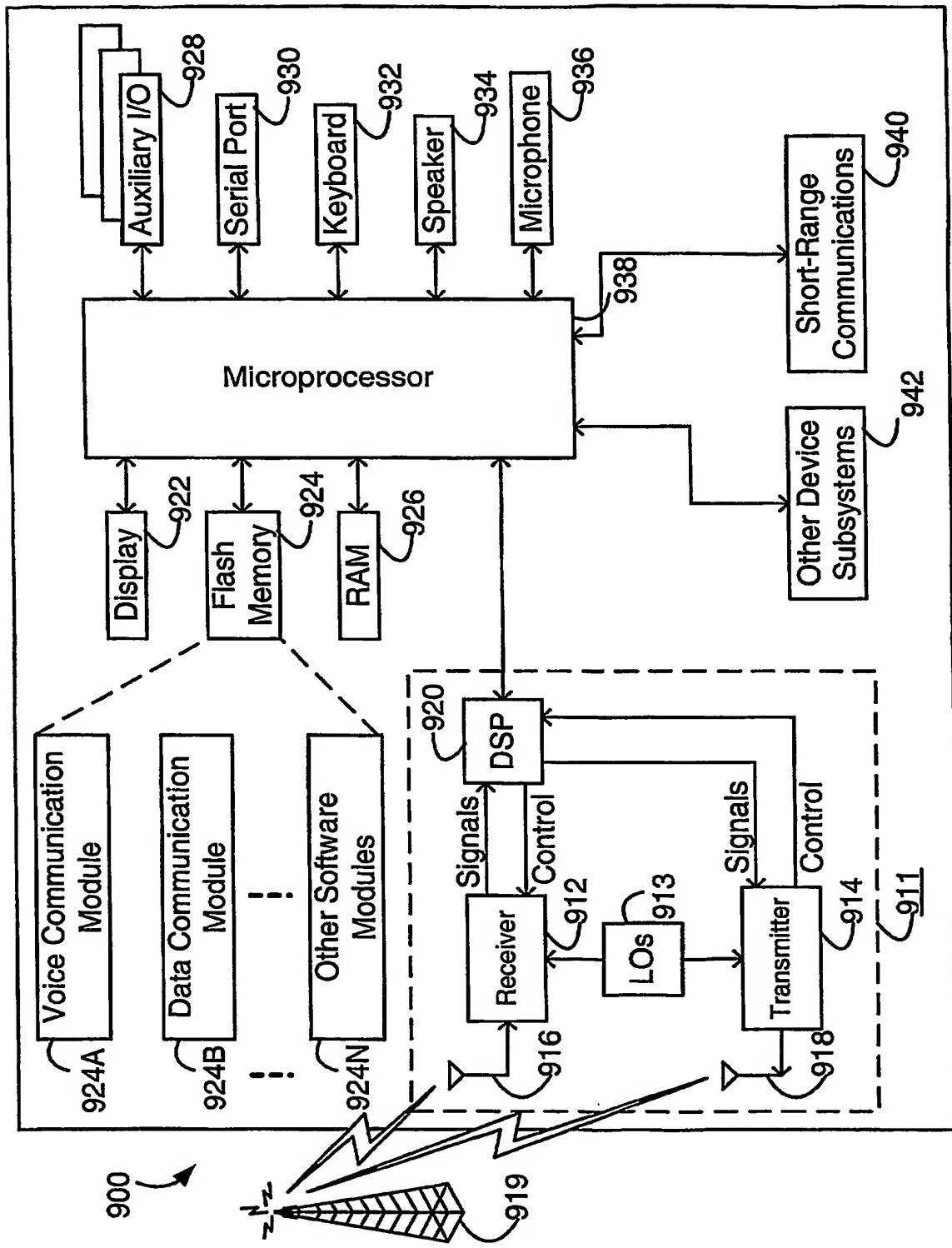


Fig. 5